PRODUCT SPECIFICATION

Rechargeable Lithium Ion Battery
Model : ICR18650HA1 1300mAh

Prepared	Reviewed	Approved
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Revision History

Revision	Date	Originator	Description
0	2006-12-27	Kim, Bong Tae	Original Release
1	2007-03-30	Kim, Hong-Jeong	Change of nominal capacity (1400 → 1300 mAh)
2	2007-10-05	Kim, Hong-Jeong	Separation of nominal capacity (Capacity for Standard and Fast charge/discharge)
3	2009-01-30	Kim, Sung Jong	Cell dimension information was specified. (Standard of cell diameter = cell head)
4	2009-07-15	Kim, Sung Jong	Cell printing was changed Max charge voltage was added
5	2010-01-28	Choi, Yeong Gwang	Change of discharge voltage (2.5V → 2.0V)

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1. General Information

1.1 Scope

This product specification defines the requirements of the rechargeable lithium ion battery to be supplied to the Customer by LG Chem.

1.2 Application: Power Tools

1.3 Product classification: Cylindrical rechargeable lithium ion battery

1.4 Model name: ICR18650HA1

2. Nominal Specification

Item	Condition / Note	Specification
2.1 Capacity	Std. charge / discharge	Nominal 1400 mAh (C_{nom}) Minimum 1300 mAh (C_{min})
	Fast charge / discharge (Condition for power tools)	Nominal 1300 mAh (C_{nom-PT}) Minimum 1200 mAh (C_{min-PT})
2.2 Nominal Voltage	Average for Std. discharge	3.7V
2.3.1 Standard Charge (Refer to 4.1.1)	Constant current Constant voltage End condition(Cut off)	0.5C (650mA) 4.2V 50mA
2.3.2 Fast charge (Refer to 4.1.3)	Constant current Constant voltage End condition(Cut off)	4000mA 4.2V 100mA
2.4 Max. Charge Voltage	-	4.2V
2.5 Max. Charge Current	-	4000mA
2.6.1 Standard Discharge (Refer to 4.1.2)	Constant current End voltage(Cut off)	0.2C (260mA) 2.0V
2.6.2 Fast Discharge (Refer to 4.1.3)	Constant current End voltage(Cut off)	10000mA 2.0V
2.7 Max. Discharge Current	For continuous charge	15000mA
2.8 Weight	Approx.	45.0 g
2.9 Operating Temperature	Charge Discharge	0 ~ 45℃ -20 ~ 60℃
2.10 Storage Temperature (for shipping state[i])	1 month 3 month 1 year	-20 ~ 60℃ -20 ~ 45℃ -20 ~ 20℃

* Shipping state : About 50% capacity of fully charged state

3. Appearance and Dimension

3.1 Appearance

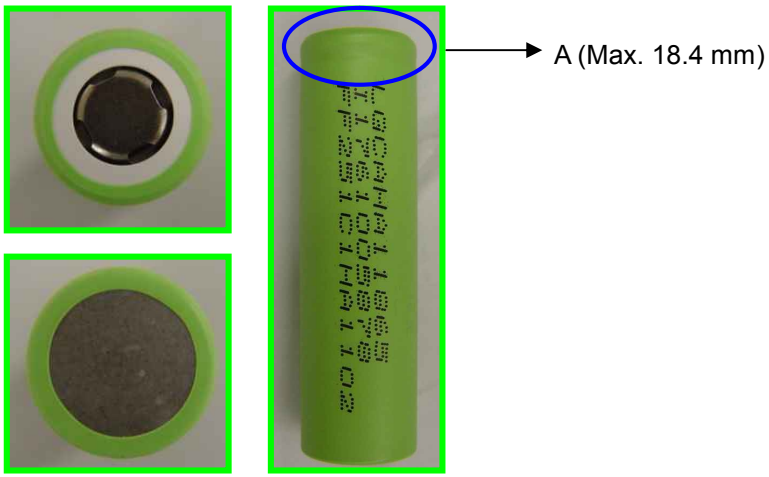
There shall be no such defects as deep scratch, crack, rust, discoloration or leakage, which may adversely affect the commercial value of the cell.

3.2 Dimension

Diameter : 18.3 + 0.1/-0.3 mm (Max. 18.4 mm)

Diameter is defined as the largest data value measured on the “A” area of a cylindrical cell.

Height : 65.0 ± 0.2 mm (Max. 65.2 mm)



4. Performance Specification

4.1 Standard test condition

4.1.1 Standard Charge

Unless otherwise specified, “Standard Charge” shall consist of charging at constant current of 650mA. The cell shall then be charged at constant voltage of 4.2V while tapering the charge current. Charging shall be terminated when the charging current has tapered to 50mA. For test purposes, charging shall be performed at 23ºC ± 2ºC.

4.1.2 Standard Discharge

“Standard Discharge” shall consist of discharging at a constant current of 260mA to 2.0V. Discharging is to be performed at 23 ºC ± 2 ºC unless otherwise noted (such as capacity versus temperature).

4.1.3 Fast Charge / discharge condition

Cells shall be charged at constant current of 4000mA to 4.2V with end current of 100mA. Cells shall be discharged at constant current of 10000mA to 2.0V. Cells are to rest 10 minutes after charge and 20 minutes after discharge.

4.2 Electrical Specification

Item	Condition	Specification
4.2.1 Initial AC Impedance	Cell shall be measured at 1kHz after charge per 4.1.1.	≤ 30 mΩ, without PTC
4.2.2 Initial Capacity	Cells shall be charged per 4.1.1 and discharged per 4.1.2 within 1h after full charge.	C_{ini} ≥ 1300 mAh (C_{min})
4.2.3 Cycle Life	Cells shall be charged and discharged per 4.1.3, 400 cycles. A cycle is defined as one charge and one discharge. 401st discharge capacity shall be measured per 4.1.1 and 4.1.2	≥ 60 % (of C_{min} in 2.1)

4.3 Environmental specification.

Item	Condition	Specification
4.3.1 Storage Characteristics	Cells shall be charged per 6.1 and stored in a temperature-controlled environment at 23ºC ± 2ºC for 30 days. After storage, cells shall be discharged per 6.2 to obtain the remaining capacity.	Capacity remaining rate ≥ 90% (C_{ini} in 2.1)
4.3.2 High Temperature Storage Test	Cells shall be charged per 4.1.1 and stored in a temperature-controlled environment at 60ºC for 1 week. After storage, cells shall be discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered capacity*.	No leakage, Capacity recovery rate ≥ 80%
4.3.3 High Temperature and High Humidity Test	Cells are charged per 4.1.1 and stored at 60ºC (95% RH) for 168 hours. After test, cells are discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered capacity.	No leakage, No rust Capacity recovery rate ≥ 80%
4.3.4 Thermal Shock Test	65ºC (8h) ← 3hrs → -20ºC (8h) for 8 cycles with cells charged per 4.1.1 After test, cells are discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered capacity.	No leakage Capacity recovery rate ≥ 80%

* Remaining Capacity : After storage, cells shall be discharged with Std. condition(4.1.2) to measure the remaining capacity.
** Recovery Capacity : After storage, cells shall be discharged with fast discharge condition(4.1.3), and then cells shall be charged with std. charge condition(4.1.1), and then discharged with Std. condition(4.1.2). This charge / discharge cycle shall be repeated three times to measure the recovery capacity.

<table>
<tr><td rowspan="3">4.3.5
Temperature Dependency of Capacity</td><td colspan="2">Cells shall be charged per 4.1.1 at 23ºC ± 2ºC and discharged with 4A to 2.0V at the following temperatures.</td><td></td></tr>
<tr><td>Charge</td><td>Discharge</td><td>Capacity</td></tr>
<tr><td>23℃</td><td>-10℃
0℃
23℃
60℃</td><td>60% of C_{ini}
80% of C_{ini}
100% of C_{ini}
95% of C_{ini}</td></tr>
</table>

4.4 Mechanical Specification

Item	Condition	Specification
4.4.1 Drop Test	Cells charged per 4.1.1 are dropped onto an oak board from 1 meter height for 1 cycle, 2 drops from each cell terminal and 1 drop from side of cell. (Total number of drops =3).	No leakage No temperature rising
4.4.2 Vibration Test	Cells charged per 4.1.1 are vibrated for 90 minutes per each of the three mutually perpendicular axes (x, y, z) with total excursion of 0.8mm, frequency of 10Hz to 55Hz and sweep of 1Hz change per minute. After test, cells are discharged per 4.1.2 and cycled per 4.1.3 for 3 cycles to obtain recovered capacity.	No leakage

4.5 Safety Specification

Item	Condition	Specification
4.5.1 Overcharge Test	Cells are discharged per 4.1.2, then charged at constant current of 3 times the max. charge condition and constant voltage of 4.2V while tapering the charge current. Charging is continued for 7 hours (Per UL1642).	No explode, No fire
4.5.2 External Short - Circuiting Test	Cells are charged per 4.1.1, and the positive and negative terminal is connected by a 100mΩ-wire for 1 hour (Per UL1642).	No explode, No fire

4,5.3 Overdischarge Test	Cells are discharged at constant current of 0.2C to 250% of the minimum capacity.	No explode, No fire
4.5.4 Heating Test	Cells are charged per 4.1.1 and heated in a circulating air oven at a rate of 5ºC per minute to 130ºC. At 130ºC, oven is to remain for 10 minutes before test is discontinued (Per UL1642).	No explode, No fire
4.5.5 Impact Test	Cells charged per 4.1.1 are impacted with their longitudinal axis parallel to the flat surface and perpendicular to the longitudinal axis of the 15.8mm diameter bar (Per UL1642).	No explode, No fire
4.5.7 Crush Test	Cells charged per 4.1.1 are crushed with their longitudinal axis parallel to the flat surface of the crushing apparatus (Per UL1642).	No explode, No fire

5. Caution and Prohibition in Handling

Warning for using the lithium ion rechargeable battery. Mishandling of the battery may cause heat, fire and deterioration in performance. Be sure to observe the following.

Caution

- When using the application equipped with the battery, refer to the user's manual before usage.
- Please read the specific charger manual before charging.
- Charge time should not be longer than specified in the manual.
- When the cell is not charged after long exposure to the charger, discontinue charging.
- Battery must be charged at operating temperature range 0 ~ 45℃.
- Battery must be discharged at operating temperature range -20 ~ 60℃.
- Please check the positive(+) and negative(-) direction before packing.
- When a lead plate or wire is connected to the cell for packing, check out insulation not to short-circuit.
- Battery must be stored separately.
- Battery must be stored in a dry area with low temperature for long-term storage.
- Do not place the battery in direct sunlight or heat.
- Do not use the battery in high static energy environment where the protection device can be damaged.
- When rust or smell is detected on first use, please return the product to the seller immediately.
- The battery must be away from children or pets
- When cell life span shortens after long usage, please exchange to new cells.

Prohibitions

- Do not use different charger. Do not use cigarette jacks (in cars) for charging.
- Do not charge with constant current more than maximum charge current.
- Do not disassemble or reconstruct the battery.
- Do not throw or cause impact.
- Do not pierce a hole in the battery with sharp things. (such as nail, knife, pencil, drill)
- Do not use with other batteries or cells.
- Do not solder on battery directly.
- Do not press the battery with overload in manufacturing process, especially ultrasonic welding.
- Do not use old and new cells together for packing.
- Do not expose the battery to high heat. (such as fire)
- Do not put the battery into a microwave or high pressure container.
- Do not use the battery reversed.
- Do not connect positive(+) and negative(-) with conductive materials (such as metal, wire)
- Do not allow the battery to be immerged in or wetted with water or sea-water.